Automating a rail-to-truck transfer terminal

Cement transfer terminals have optimised their operations through automating as many tasks as possible. Reducing truck turnover at the terminal is key to customer satisfaction. PENTA has installed both new and retrofitted rail-to-truck transfer terminals around the USA for many cement producers. The automation controls and programs are developed by observing the manual process followed by terminal operators.

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To reduce terminal investment costs, project owners minimise capital expenditure. After all, the terminal provides a convenience to the buyer of cement and not necessarily a considerable return on investment for the owner. One way of reducing the cost is to provide a single truck load-out point with one or more storage silos, depending on the terminal's throughput rate and cement types to be stored. However, the single load-out station requires expedient loading systems to keep trucks moving without delay. Using an optimised automated system reduces human error and uploading time, while increasing safety for plant operators.

The automation of the terminal requires the independent programming of two distinct processes:

1. cement unloading and storage – cement is unloaded from railcars to storage silos
2. cement distribution – cement is loaded from storage silos to client trucks that dispatch the product to its final destination.

Truck hatch safety access platform

Cement unloading and storage

The cement arrives at the plant in bulkbox covered railcars and is transferred to storage bins or silos, using either mechanical or pneumatic materials handling systems, or a combination of both. Ancillary equipment such as gates and valves control the flow of cement depending on the destination storage. Historically, the terminal operator would regulate the flow from the control room by using a push-button panel or a computer station. This also requires a significant amount of field work in preparation for the rail car unloading process. However, when the operator selects unsuitable equipment or incorrectly positions the valve, operational issues arise. Despite the efficiency and skillfulness of an operator, human error may occur. Most of the time this results in delays, but critical product outcomes can also be affected. In either case, these delays and outcomes lower operational efficiency.

To support unloading operations, the PENTA Pit is a fully-automated system for rapid railcar unloading, used to receive and transfer cement from the railcar to the bucket elevator. The system includes an underground rail pit with gathering screw conveyors (or air gravity conveyors) that transport the material to the bucket elevator. The unloading system is partially enclosed and designed to eliminate spillage, while also being economical and low maintenance. Pneumatically-operated socks lift up from the pit to fit to the railcar discharge gate flanges. A pneumatically-operated cylinder assists in the opening of the railcar discharge slide gates or clam-shell valves. Once the railcar is ready to be unloaded, the operator can define the destination bin based on cement type or

Traffic lights regulate the flow of trucks into the loading area

any other criteria. The display screen in the control room shows the operator the load level of each of the bins as well as the type of cement that it matches with the railcar bill of lading. Once the destination is set, a click by the operator's mouse will set the unloading process in motion. Instrumentation installed throughout the course of material flow monitors the process and can generate alarms or shut the system down in case of any malfunction, or if the bin reaches the high level indicators.

Loading and dispatch operations

Cement stored in bins or silos is loaded into trucks using various types of material handling equipment depending on the arrangement of the storages with respect to the truck loading station(s).

This truck loading process was traditionally the responsibility of the terminal personnel. The operator would process the order in the control room (ie type of cement and quantity), then climb stairs to the truck hatch access platform, open the hatch, direct the driver to move the truck if necessary, lower the spout and push the start button. This would start a sequence of actions by material flow equipment, with valves controlling the flow volume until the truck weighing scale would control and eventually stop the flow of material once the specified load was reached.

The introduction of programmable logic controllers (PLCs) had already improved the process of flow control to the trucks to prevent overfilling. When a truck is overfilled, cement may be spilled and to meet transportation requirements, the truck needs to be driven to an unloading station to blow material back to a bin. This takes time and affects the terminal's efficiency of serving customers.

Current technology allows the plant to integrate a fully-automated loading system that relies on controls to reduce human activity and improve loading accuracy. As a result, it significantly increases the throughput of the terminal – ie, the number of trucks that can be serviced in an hour. These systems include hardware and software that automate the loading procedures:

1. Regular customers register with the terminal to process order requests directly from their facilities.
2. Cement trucks enter the plant and are automatically identified through radio frequency identification (RFID) technology. The terminal system informs the driver of their loading order number via a screen where all the data relating to the order is visible to the driver.
3. A safe hatch opening station is provided for the driver to climb and open the trailer hatch ahead of the loading station.
4. After opening loading hatches, the driver proceeds to the load-out area where an automated vision system locates the trailer open hatch and automatically places the loading spout to start the loading procedure. To enable this, modern loading spouts are designed for triaxial movement.
5. The scale under the load-out area feeds the truck-trailer tare weight data to the loading system. This allows the PLC to determine the set points to be used for controlling the flow to the trailer.
6. The driver has access to a push-button station from where a panel will show the details of the pick-up order and indicate that the trailer is ready to be loaded.
7. The driver will verify that the data of the order is correct and push a green button to allow the system to activate.
8. Blowers, valves and dust collectors will start in a predetermined sequence and cement starts flowing from the appropriate silo to the loadout spout. Flow control valves regulate the rate of material passing through the material handling equipment. When the load approaches 90 per cent of the target load, the flow control valve starts trimming the rate until the full load is reached, at which point the flow will stop.
9. When the filling process is complete, the bill-of-lading will be printed for the driver. Traffic lights signal the truck to exit the load-out area. All the information is stored and transmitted to the terminal office, the cement company's corporate office for invoicing and inventory control, the customer's office and the truck driver's computer if an electronic version of the bill-of lading has been requested.

With the use of automated controls, the PLC controls the whole sequence in a programmed manner. It relies on the feedback given by the equipment as inputs and controls equipment by generating output. Moreover, it continuously reads the process status as different inputs. If there is any issue during the process, it immediately generates an alarm/warning. The operator reads the information on HMI and takes appropriate action. Each time a truck is loaded, the weight is close to perfect. It continuously reads the weight and controls the process.

There are numerous advantages to automated controls, including efficiency and proactivity. Aside from saving time, automating the system allows the sequencing of equipment to fully empty material handling equipment to prevent contamination when two or more types of materials are handled by the same equipment.

Conclusion

The automated control of cement loading and unloading is beneficial, saving operating costs for the owner of a cement transfer terminal, serving customers more expeditiously as well as improving quality control and the safety of the truck drivers and terminal staff. The experience to design and program the automation system is derived by observing the operations of cement transfer terminals and working closely with the owners and their operators to provide efficient customised systems. ■